



NEWS RELEASE
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Directorate of Public Affairs, Arnold Engineering Development Center
100 Kindel Drive, Arnold AFB, TN 37389-2213 (931) 454-4204
<http://www.arnold.af.mil>

AMERICA'S AIR & SPACE ADVANTAGE

Writer: Compiled by Janae' Daniels

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Tennessee playing a role in shuttle Return to Flight

ARNOLD AIR FORCE BASE, TENN—The United States Air Force's Arnold Engineering Development Center (AEDC), located at Arnold Air Force Base in Tennessee, played an important role in supporting NASA's Space Shuttle Return to Flight program will culminate with the launch of Space Shuttle Discovery as early as July 13.

Following the break up of Columbia during re-entry in February 2003, AEDC facilities and personnel experienced in manned space program testing responded to help NASA return to manned space flight. Return to Flight tests were conducted in five of AEDC's 58 testing facilities.

Here is a synopsis of the tests conducted at AEDC.

Wind Tunnel Testing

The first of three series of wind tunnel tests occurred in June 2003 in AEDC's Tunnel A. These tests demonstrated the aerodynamic capabilities of some of the Space Shuttle redesign initiatives and provided valuable data on the aerodynamic heating caused by the new design during ascent.

Mounting an AEDC-designed and fabricated 100-percent scale metal model of the bipod ramp that connects the space shuttle to the main external fuel tank near the shuttle's nose in the tunnel, test personnel generated an environment similar to that encountered at various launches to orbit to observe the aerodynamic flow conditions.

The second series of tests began in the center's 4-foot transonic wind tunnel in August 2003. There, test crews measured the air pressure on models of the same bipod, ramp and a redesigned bipod area by placing pressure sensors in the models.

Embedded heaters on the insulation foam models prevented ice formation on the exposed metal components during tests and allowed the predicted flight structural thermal profile to be very accurately simulated.

AEDC fabricated a new wind tunnel side wall that integrated model features with the test facility to more closely match the flight airflow conditions in the bipod area.

Another series of tests were conducted in the center's hypersonic Tunnel C. During this series, an AEDC-designed and fabricated 30-percent scale redesigned bipod model was used to collect the heating rates and pressure measurements from locations distributed around the redesigned bipod attachment fitting and surrounding insulation foam.

Foam Impact Testing

Engineers and test operators in AEDC's S-3 Ballistic Impact Range launched hundreds of block-shaped projectiles made of the insulating foam material used on the shuttle's external tank. These "shots" simulated pieces of external tank foam breaking away from the tank during flight, as happened to Columbia, and striking various parts of the space shuttle such as the solid rocket booster (SRB).

Test operators launched the blocks at various velocities and angles to simulate the different ways in which foam might strike the SRBs. These tests helped determine the effects of foam impact and provided information on the rocket booster's ability to withstand those impacts.

During each shot, high-pressure helium gas launched the foam projectiles at speeds from 150 to 2,255 feet per second down a 86-foot-long rectangular barrel.

The targets included the struts connecting the solid rocket booster and external fuel tank, core panels representative of the thermal protection system materials and cover material for the range safety system antennae that would be used to abort a mission if sufficient damage occurred to the shuttle.

High-speed video cameras operating at speeds up to 20,000 frames per second documented the impacts and provided a means for measuring the velocity of the projectiles. In instrumentation on the target's panels acquired data at 50,000 samples per second to provide information on the stresses the targets sustained during the impact.

"Full stack" testing

AEDC completed a week of testing on a three-percent scale "full stack" model in the center's 16-foot transonic wind tunnel in October 2004. The "full stack" model represents a space shuttle configuration similar to the vehicle at launch, with the external fuel tanks attached.

The objective of the test was to perform detailed pressure and force measurements, and flow visualization on the shuttle model, particularly in the bipod area. The model was subjected to speeds ranging from those encountered just after takeoff to Mach 1.5.

Pressure sensitive paint flow visualization was used to determine pressure data over the entire surface of the shuttle model as it was tested. This specialized paint fluoresces or glows under certain lighting, with brighter areas indicating lower pressure and dimmer areas indicating higher pressure. The paint is applied to the model, which is then imaged with digital cameras while the wind tunnel is operating. The images are processed through a program in a supercomputer to show the varying pressures in different colors. The team acquired pressure data on the two versions of external tanks including the newer super lightweight tank and the older standard weight tank that dates to the late 1970s, to compare aerodynamic performance.

During the force phase of the test, parts of the liquid oxygen fuel system were installed onto small balances. Forces on these components were measured over a range of simulated flight conditions and model attitudes, including the roll maneuver that occurs shortly after take-off. NASA used the AEDC PSP flow visualization data to validate the computational fluid dynamics data it generated in testing at NASA facilities.

The people of AEDC are proud of the important role they played in returning the shuttle to flight.

AEDC has a long history of supporting the nation's manned space programs. AEDC played a key role in the development of projects Mercury, Gemini and Apollo. The center also provided critical testing to the development of the space shuttle.

Editorial Note:

Arnold Engineering Development Center is the nation's largest complex of flight simulation test facilities. The center was dedicated in June 1951 by President Harry Truman and named after 5-star General of the Air Force Henry 'Hap' Arnold, visionary leader of the Army Air Forces in World War II and the only Airman to hold 5-star rank. Today, this \$7.8 billion complex has 58 aerospace test facilities located at Arnold Air Force Base, Tenn., and the center's remote operating location Hypervelocity Tunnel 9 in White Oak, Md. The test facilities simulate flight from subsonic to hypersonic speeds at altitudes from sea level to space. Every high performance flight system in use by the Department of Defense today and all NASA manned spacecraft have been tested in AEDC's facilities. Today the center is testing the next generation of aircraft and space systems. For more information on AEDC visit the center's Web site at www.arnold.af.mil.

Caption for d0408565—Machinist Larry Phipps at the Air Force's Arnold Engineering Development Center loads a foam projectile into an 86-foot-long rectangular barrel used to conduct impact testing for the Space Shuttle Return to Flight program.

Caption for d0507010—Pressure sensitive paint flow visualization data from a three-percent model of the space shuttle tested at the Air Force's Arnold Engineering Development Center's long transonic wind tunnel was used to validate computational fluid dynamics data generated by NASA.

Caption for d0410516—A “blue light” photo of the “full stack” space shuttle model in 16-foot transonic wind tunnel at the Air Force's Arnold Engineering Development Center.

Caption for d0410474—Jim Greathouse, computational fluid dynamics (CFD) analyst, left to right, Darby Vicker, CFD analyst, and Bob Ess, program manager, all from NASA Johnson Space Center, examine the shuttle model during a model change at in the 16-foot transonic wind tunnel at the Air Force's Arnold Engineering Development Center.

Caption for d0507020—Still photo of a space shuttle block foam impact test on the shuttle's bipod area at speeds up to 2,255 feet per second was performed at the Air Force's Arnold Engineering Development Center's Ballistic Impact Range S-3. (AEDC photos)

TO NEWS EDITORS - Interview opportunities are available on this subject as is broadcast quality video of some of these tests. Call Andy Roake at (931) 454-4206.

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